

Identification of Location and Nature of Organic Matter and Contaminants on Sediments

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PROJECT GOAL:

The purpose of this research is to investigate using spectroscopic and spectrometric methods the microscale locations and associations of organic contaminants and natural organic matter in natural sediments. Such knowledge is important in understanding the fundamental nature of sorption mechanisms that govern organic contaminant bioavailability. Organic contaminants that are being investigated in this study include polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and nitroaromatics such as TNT. The role of hard carbonaceous materials in sediments such as coal-derived particles and soot is an important aspect of this research due to the unique strong binding of the organic contaminants to these sorbents.

PROJECT ACCOMPLISHMENTS:

Measurements have been conducted at the sub-particle level to understand where PAHs reside on aged sediments and how such locations relate to the presence and nature of sediment organic matter. Infrared microspectroscopy at the ALS beamline 1.4 was used to identify organic carbon location in sediment particles. Scanning electron microscopy with wavelength dispersive X-ray analysis was used for elemental microanalysis and microprobe two-step laser desorption laser ionization mass spectrometry ($\mu\text{L}^2\text{MS}$) was used for PAH measurements at Stanford University. In this work, black carbonaceous particles derived from coal were found to have 2-3 orders of magnitude more PAHs than silica particles. It has been suggested previously that PAHs partition into organic carbon on soils and sediments as a process of aging. However, organic carbon can be present in soils and sediments in various forms such as humic matter particles, humic matter sorbed on mineral surfaces, detrital debris, vegetative debris, and products of coal and wood use and combustion. Little is known about the relative importance of these different forms of organic carbon in the sequestration of PAHs in sediments. Our investigations reveal that for Milwaukee Harbor sediments, coal-derived particles contribute nearly 62% of total PAHs and constitute only 5% of the sediment by weight. The remaining 38% of the PAHs were found associated with the clay/silt fraction of the sediment. Transmission FTIR spectral analysis of the clay/silt fraction revealed that the organic environment associated with the clay/silt fraction is much more aliphatic in nature than the organic environment of the coal-derived particles. Therefore PAH binding is expected to be different in these two different organic environments. Results from this work have been presented in the ALS 1999 abstracts and have been published recently [1,2]. In related ongoing research we are finding that PAHs associated with coal-derived particles in sediments are strongly bound and apparently not available to microorganisms and earthworms [2]. The unavailable PAH fraction associated with coal-derived particles in these sediments may pose less environmental risk.

FUTURE WORK:

Work in the next one year will focus on extending the above research to several other natural sediment and soil materials as part of two new research projects: 1) Under a new research grant from the Strategic Environmental Research and Development Program we will be investigating the microscale associations of PAH and PCB contaminants with organic matter in sediments from San Francisco Bay and the beneficial effect of carbonaceous sorbents. 2) Another research project

involves microscale identification of the nature of association of nitroaromatics such as TNT to soil particles. Work will also involve identifying the IR spectral characteristics of several naturally available organic carbon types such as coal, soot, char, and charcoal.

REFERENCES:

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